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(19) (CA) **CANADIAN PATENT** (12)

(54) Process for Manufacturing Spunbonded Webs

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The present invention relates to a process for manufacturing spunbonded webs from spun fibers or filaments by blow-spinning a melt or a solution of a spinnable polymeric material by means of a die head which has one or
5 more die openings, and a collector.

German Offenlegungsschrift No. 1,964,060 discloses manufacturing spunbonded webs by blow-spinning a polypropylene melt. Spunbonded web manufacture by blow-spinning also includes, incidentally, the conventional process as
10 disclosed for example in French Patent No. 1,364,916.

German Offenlegungsschrift No. 1,900,265 likewise discloses a process for manufacturing spunbonded webs by spray-spinning (blow-spinning) fiber-forming polymers. It is pointed out in this publication that any organic polymer
15 which is processable by melt-spinning or solvent-spinning can be used as the fiber-forming polymers in the process. Polyolefins, for example polypropylene and polyethylene, and also cellulose acetate and triacetate, polyamides, polyacetals, polyesters and acrylic polymers are mentioned.

20 However, the spunbonded webs made from spun fibers or filaments using these known processes have the following disadvantages:

- for purposes such as thermal insulation their density is too high, in particular when they consist of
25 microfibers or filaments;
- for use as a filter material; and
- as a consequence of their high density - their gas, vapor and liquid permeability are too low.

It is known from U.S. Patent No. 4,118,531 to
30 reduce the density of spunbonded webs produced by blow-spinning microfibers - and hence to increase their bulk - by blowing crimped spun fibers (staple fibers), that is to say fibers of limited length, into the stream of blow-spun microfibers. However, such a process has the disadvantage,



inter alia, that it is not possible to distribute the crimped spun fibers uniformly in the spunbonded web, because, owing to their limited length and their crimp, they become tangled with one another in the course of blowing-in. This leads to agglomerations of these crimped spun fibers and hence to spunbonded webs of non-uniform density.

It is the object of the present invention to provide a process of the type described at the beginning whereby it is possible, without the need for additional process steps after that of blow-spinning, to produce spunbonded webs which have a low and in particular uniform density and, for use as a filter material, an improved, that is to say increased, gas, vapor and liquid permeability.

According to the present invention, there is provided a process for manufacturing spunbonded webs from fibers and filaments by blow-spinning a melt or a solution of a spinnable polymeric material using a die head which has one or more die openings, and a collector, wherein in the area between the die opening(s) and the collector, at least one crimped monofilament or at least one crimped filament yarn or both are applied or introduced under tension to or into a mass of the spun fibers and filaments which form the spunbonded webs by blowing, using filament or filament yarn feed nozzles, the monofilaments and filament yarns having a modulus of at least 1 cN/dtex.

The advantage of blowing monofilaments or filament yarns on or in a spunbonded web using filament or filament yarn feed nozzles is that therewith the monofilaments and filament yarns can be applied to or introduced into the mass of the spun fibers or filaments forming the spunbonded webs in a controlled manner, as a result of which, it is possible to obtain an even better, that is to say, even more uniform, distribution of the monofilaments and filament yarns on or in the mass of the spun fibers or filaments and

hence on or in the spunbonded web.

For the purposes of the invention, the spinable polymeric materials used can be all those which are processable by melt-spinning or solvent-spinning (dry-spinning). Thus, polyolefins, such as polyethylene and polypropylene, polyesters, such as polyethylene terephthalate, polyamides, such as nylon-6.6 and nylon-6, cellulose esters, such as secondary acetate rayon and cellulose triacetate, and acrylic polymers, such as polyacrylonitrile are suitable.

Suitable crimped monofilaments and filament yarns are for example those which have been given a crimp by false-twist crimping, air-jet crimping or stufferbox crimping.

The monofilaments and filament yarns can consist for example of polyolefins, such as polyethylene and polypropylene, polyesters, such as polyethylene terephthalate, polyamides, such as aromatic polyamides, nylon-6 and nylon-6.6, cellulose esters, such as secondary acetate rayon and cellulose triacetate, and acrylic polymers, such as polyacrylonitrile.

Specific examples are a false-twist crimped five-filament 22-dtex nylon-6.6 yarn and a false-twist crimped 13-filament 44-dtex nylon-6.6 yarn. The monofilaments and filament yarns, however, can also have a much lower or higher linear titer.

As above indicated, the monofilaments and filament yarns have a modulus of at least 1 cN/dtex.

The modulus (also referred to as modulus of elasticity or initial modulus) is obtained from the slope of the tangent to the first - linear - part of the stress-strain curve in which the stress per dtex is plotted on the Y-axis against the strain on the X-axis. The stress-strain curve is

in each case determined by a tensile test in accordance with DIN 53834.

Illustrative embodiments of the invention are further explained hereinafter by reference to the drawings, in which

Fig. 1 schematically depicts an apparatus for carrying out the process according to the invention in cross-section. This illustration shows the embodiment whereby crimped - monofilaments or - crimped - filament yarns are applied to the mass of the spun fibers or filaments or both forming the spunbonded web, by means of deflecting rollers 5;

Fig. 2 schematically depicts an apparatus for carrying out the process according to the invention in cross-section. This illustration shows the embodiment whereby - crimped - monofilaments or crimped - filament yarns are blown onto the mass of the spun fibers or filaments or both forming the spunbonded web, by means of filament and filament yarn feed nozzles 8 respectively;

Fig. 3 schematically depicts an apparatus for carrying out the process according to the invention in cross-section. This illustration shows the embodiment whereby - crimped - monofilaments or - crimped - filament yarns are introduced into the mass of the spun fibers or filaments or both forming the spunbonded web, by means of deflecting rollers 5;

Fig. 4 schematically depicts an apparatus for carrying out the process according to the invention in cross-section. This illustration shows the embodiment whereby - crimped - monofilaments or - crimped - filament yarns are blown

into the mass of the spun fibers or filaments or both forming the spunbonded web, by means of filament and filament yarn feed nozzles 8 respectively; and

Fig. 5 shows a view of the apparatus according to the invention in direction A of Figure 3 from the cross-sectional plane indicated there. This illustration shows that the deflecting rollers 5 according to Figure 3 are each arranged - centrally - between two adjacent die openings 2 underneath a die head 1.

The apparatus of Figure 1 has a die head 1 with die openings 2, a collector 3 and deflecting rollers 5. The deflecting rollers 5 are arranged so close to the side of the mass 6 of the spun fibers or filaments which emerge from the die openings 2 and which form the spunbonded web 7 that the crimped monofilaments 4 or crimped filament yarns 4 or both which are supplied via these deflecting rollers 5 are carried along by the gas stream which is caused by the blow-spinning and accompanies the mass 6 of the spun fibers or filaments and is referred to as the primary gas stream and are conveyed onto the mass 6 of the spun fibers or filaments. The crimped monofilaments or filaments may be applied transverse to the direction of flow of the mass of spun fibers and filaments which form the web.

The apparatus of Figure 2 has a die head 1 with die openings 2, a collector 3 and filament and filament yarn feed nozzles 8. The feed nozzles 8 are arranged at the side of the mass 6 of the spun fibers or filaments which emerge from the die openings 2 and form the spunbonded web 7. By means of the

feed nozzles 8, which can be operated with compressed air or some other pressurized gas, the crimped monofilaments 4 or the crimped filament yarns 4 are supplied to the mass 6 of the spun fibers or filaments. For this, the pressure of this air or gas is set in such a way that the monofilaments 4 or the filament yarns 4 are blown onto the mass 6 of the spun fibers or filaments, that is to say they do not penetrate into this mass 6, whereafter they are carried along by the gas stream which is caused by the blow-spinning and accompanies the mass 6 of the spun fibers or filaments and is referred to as the primary gas stream.

The apparatus of Figure 3 comprises a die head 1 with die openings 2, a collector 3 and deflecting rollers 5. The deflecting rollers 5 are each arranged underneath the die head 1 centrally between two neighboring die openings 2, so that the crimped monofilaments 4 or crimped filament yarns 4 fed via these deflection rollers 5 are introduced into the interior of the mass 6 of the spun fibers or filaments emerging from the die openings 2 and forming the spunbonded web 7. Thereafter they are carried along by the gas stream which is caused by the blow-spinning and accompanies the mass 6 of the spun fibers or filaments and is referred to as the primary gas stream.

The apparatus of Figure 4 has a die head 1 with die openings 2, a collector 3 and filament and filament yarn feed nozzles 8. The feed nozzles 8 are arranged to the side of the mass 6 of the spun fibers or filaments which emerge from the die openings 2 and form the spunbonded web 7. By means of the feed nozzles 8, which can be operated with compressed air or some other pressurized gas, the crimped monofilaments 4 or the

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crimped filament yarns 4 are supplied to the mass 6 of the spun fibers or filaments. For this, the pressure of this air or of the gas is set in such a way that the monofilaments 4 or the filament yarns 4 are blown into the interior of the mass 6 of the spun fibers or filaments. Thereafter, they are carried along by the gas stream which is caused by the blow-spinning and accompanies the mass 6 of the spun fibers or filaments and is referred to as the primary gas stream.

The invention will now be described with reference to the following examples which are not considered to limit the invention.

Example 1

(Comparative Example)

This example was performed on the apparatus of Figure 4, except that the filament and filament yarn feed nozzles 8 were not in operation, so that no crimped monofilament 4 or crimped filament yarns 4 or both were blown into the mass 6 of the spun fibers or filaments emerging from the die openings 2 and forming the spunbonded web 7.

Polypropylene having a melt flow index at 230°C/2.16 kg of 13 g/10 min, a density at 23°C of 0.902 g/cm³ and a melting range of 165-170°C was melted and spun (blow-spun) by means of die head 1, which was similar to that of German Patent 2,550,463, though the die openings 2 to give spun fibers and filaments which had an average diameter of 1.0 μ m. The spun fibers and filaments were laid onto the collector 3, which consisted of a rotating drum, to form the spunbonded web.

The web obtained had a weight per unit area of 170 g/m², a thickness of 6 mm and an air permeability of 600 m³/m².h at a differential pressure of 490.35 Pa.

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Example 2

10 This example was likewise carried out using the same apparatus and the same polymer as in Example 1. The conditions corresponded to those of Example 1 except that in addition one of the filament or filament yarn feed nozzles 8, which was similar to the nozzle described in German Utility Model 7,306,184 published on May 17, 1973 and having as applicant Farbwerke Hoechst AG, vormals Meister Lucius und Bruening, was in operation. Using this one feed nozzle 15 8, which was operated with compressed air, a false-twist crimped five-filament 22-dtex nylon-6.6 yarn having a modulus of 21 cN/dtex was supplied to the mass 6 of spun fibers and filaments, at an angle of 45° to the direction of flow of this mass 6. For this, the air pressure with which the feed 20 nozzle 8 was operated had been adjusted in such a way that the nylon-6.6 filament yarn was blown into the interior of the mass 6 of spun fibers and filaments. The nylon-6.6 filament yarn was carried along by the primary gas stream (a hot air stream) accompanying the mass 6 of fibers and 25 filaments and randomly distributed within the mass 6 of spun fibers and filaments.

The mass 6 of spun fibers and filaments including the nylon-6.6 filament yarn was laid on the collecting drum 3, the speed of rotation of which was the same as in Example 30 1, to form a spunbonded web.

the web obtained has a weight per unit area of 251 g/m² and a thickness of 15 mm. The measurement of air

permeability on this web gave a value of $1,200 \text{ m}^3/\text{m}^2.\text{h}$ at a differential pressure of 490.35 Pa.

Example 3

Example 2 was repeated, except that the one feed nozzle 8 was used to blow not the false-twist crimped 5-filament 22-dtex nylon-6.6 yarn but a false twist crimped 13-filament 44-dtex nylon-6.6 yarn having a modulus of 24 cN/dtex into the interior of the mass 6 of spun fibers and filaments, again at an angle of 45° to the direction of flow of this mass 6. This 13-filament 44-dtex nylon-6.6 yarn was likewise carried along by the primary gas stream accompanying the mass 6 of spun fibers and filaments and randomly distributed within the mass 6 of spun fibers and filaments.

The spunbonded web removed from the rotating collecting drum 3 had a weight per unit area of 230 g/m^2 and a thickness of 22 mm. The measurement of air permeability on this web gave a value of $1,800 \text{ m}^3/\text{m}^2.\text{h}$ at a differential pressure of 490.35 Pa.

It is also possible for the filament or filament yarn feed nozzles 8, which were arranged fixedly for carrying out Examples 2 and 3, to be arranged pivotably. The same is true of the deflecting rollers 5. It is thereby possible to obtain an even better, that is to say, even more uniform, distribution of the monofilaments or filament yarns or both on or in the spunbonded web.

Example 4

To describe the elastic properties of melt-blown webs with introduced or applied crimped filament yarns according to the present invention, the elastic extensibility was measured

and compared with that of a similar conventional melt-blown web. Example 2 was repeated with the exceptions noted below to make the samples.

Experimental Samples:

Sample 1: Melt-blown polypropylene web according to the invention, with a blown-in textured 44-dtex 13-filament nylon yarn, having a basis weight of about 380 g/m² and weld dots at intervals of 40 mm.

Sample 2: (Comparative Sample)

Melt-blown polypropylene web having a basis weight of about 350 g/m² and an average fiber diameter of 2.5 - 3.0 m.

Measured Results

TABLE

Total extensibility E tot: Elastic extensibility E elast.

	<u>Sample 1</u>	<u>Sample 2</u>
10%	9%	2%
25%	17%	5%
50%	34%	Total extension by 50% not possible

The elastic extensibility E elast. is obtained by the formula

$$E \text{ tot.} = E \text{ elast.} + E \text{ irrev.},$$

where the irreversible extension E irrev. was measured under the following conditions:

Time under load: 45 min

Sampling : 1st sample on removal of load
2nd sample 60 min after removal
of load
3rd sample 180 min after removal
of load

The table shows that melt-blown webs according to the invention are approximately four times more elastic than conventional melt-blown webs without crimped filament yarns.

If crimped monofilaments or the crimped filament yarns are applied to or introduced into the mass of the spun fibers or filaments or both which form the spunbonded webs by blowing on or in by means of filament or filament yarn feed nozzles under tension, the following further unexpected results are obtained:

1. a high elasticity of the ready-produced spunbonded webs; and
2. a more three-dimensional arrangement of the spun fibers or filaments or both in the ready-produced spunbonded web.

By being blow in or on under tension the monofilaments or filament yarns are initially elastically (not plastically) extended, so that at the instance of the blowing in or on the crimp is - temporarily - no longer present. The crimp on the monofilaments or filament yarns reappears at or within the spunbonded web itself, because the filaments or filament yarns were only elastically extended. The result is a high elasticity of the ready-produced spunbonded webs. Such a high elasticity is very important for example if the spunbonded

webs obtained according to the invention are used for textile purposes, for example as interlinings for apparel. This is because such interlinings are used to avoid the bulging of pieces of clothing, for example at the elbow.

As already explained above, by performing the blowing in or on under tension the monofilaments or filament yarns are initially extended elastically, so that the crimp is temporarily no longer present. The fact that according to our invention the crimp reappears within or at the spunbonded web makes the rather two-dimensional arrangement of the spun fibers or filaments or both in a prior art spunbonded web more three-dimensional or uniform density.

Another factor is that, in the known two-dimensional arrangement, the spun fibers or filaments are preferentially oriented in one direction, namely in machine direction. By contrast, the present invention makes it possible, for example by transverse blowing in or on of the crimped monofilaments or filament yarns, to arrange the spun fibers or filaments or both of the spunbonded web themselves in various directions (that is not only in machine direction).

Finally, it is also important that the more three-dimensional arrangement of the spun fibers or filaments or both in the ready-produced spunbonded web according to the invention also results in a more or less pronounced surface structure (a "figured surface"). This is important for example when the spunbonded webs according to the invention are used for the production of artificial leather.

The invention has the following advantages:

By means of the process according to the invention it is possible to manufacture spunbonded webs which have a low and uniform density and an increased gas, vapor and liquid permeability without additional process steps after the blow-spinning step. Elasticity is also improved.

The embodiment of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A process for manufacturing spunbonded webs from fibers and filaments by blow-spinning a melt or a solution of a spinnable polymeric material using a die head which has one or more die openings, and a collector, wherein in the area between the die opening(s) and the collector, at least one crimped monofilament or at least one crimped filament yarn or both are applied or introduced under tension to or into a mass of the spun fibers and filaments which form the spunbonded webs by blowing, using filament or filament yarn feed nozzles, the monofilaments and filament yarns having a modulus of at least 1 cN/dtex.
2. The process according to claim 1, wherein the crimped monofilaments or filament yarns are blown transverse to the direction of flow of the mass of the spun fibers and filaments which form the spunbonded webs.
3. The process according to claim 1, further comprising a density of about 0.01 gram per cubic centimeter.
4. The process according to claim 1, wherein the yarn is 44 dtex 13-filament polyamide yarn.
5. The process according to claim 1, wherein the yarn is 44 dtex polyamide 6.6 yarn having a modulus of 24 cN/dtex.
6. The process according to claim 1, wherein the yarn is 22 dtex polyamide 6.6 yarn.

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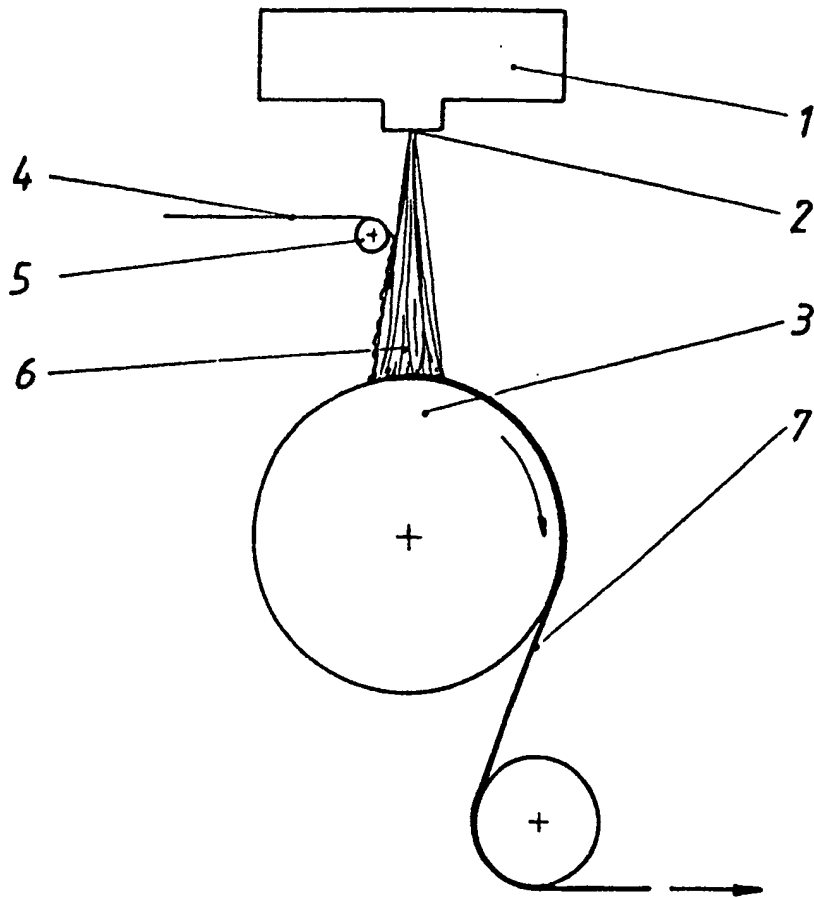
7. The process according to claim 1, wherein the filament or yarn is of polyolefin, polyester, polyamide, cellulose ester or acrylic polymer.

8. The process according to claim 7, wherein the filament or yarn is of polyethylene, polypropylene, polyethylene terephthalate, aromatic polyamide, secondary acetate rayon, cellulose triacetate, or polyacrylonitrile.

9. The process according to claim 1, wherein the fibers or filaments are blown in or at an angle of 45° to the direction of flow of the mass of the spun fibers and filaments which form the webs.

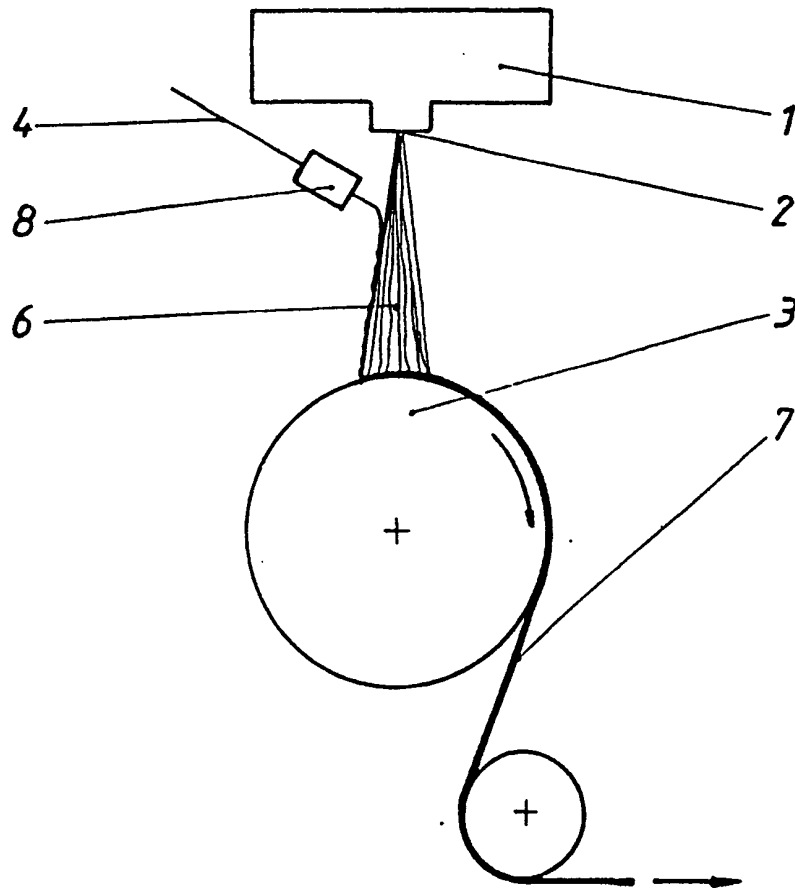
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Fig. 1

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Fig. 2

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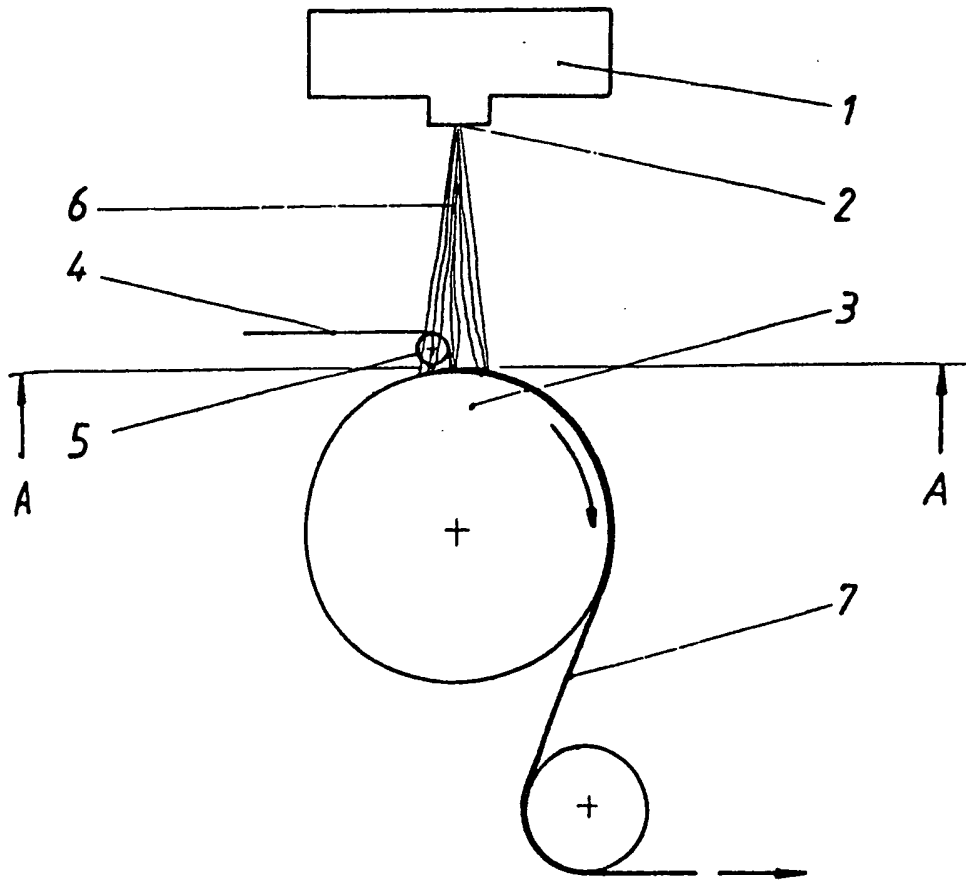


FIG. 3

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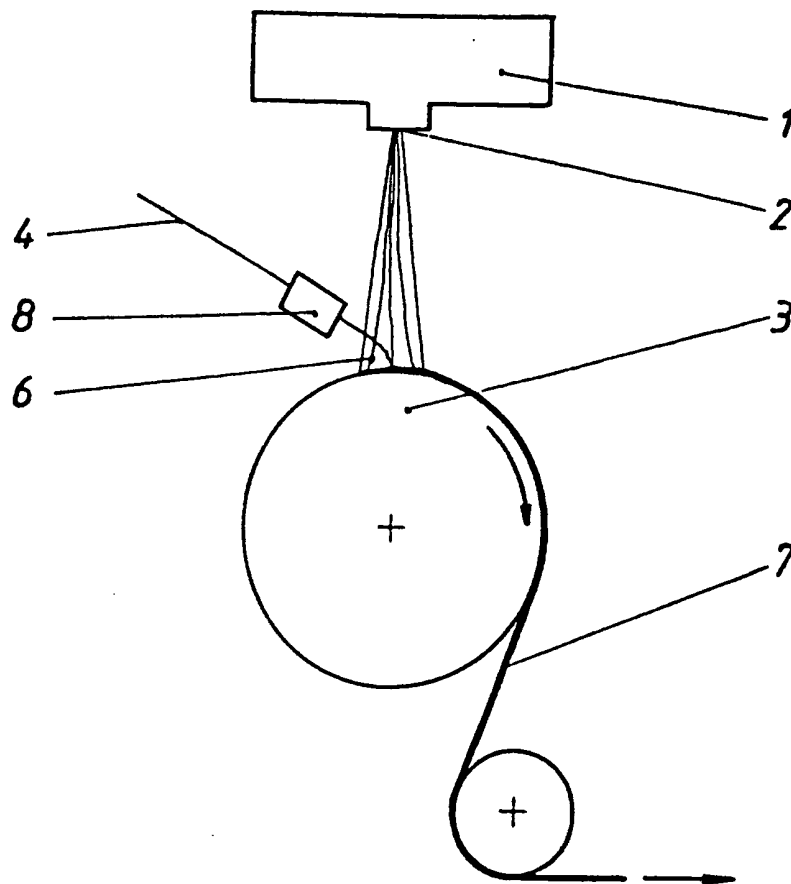


Fig. 4

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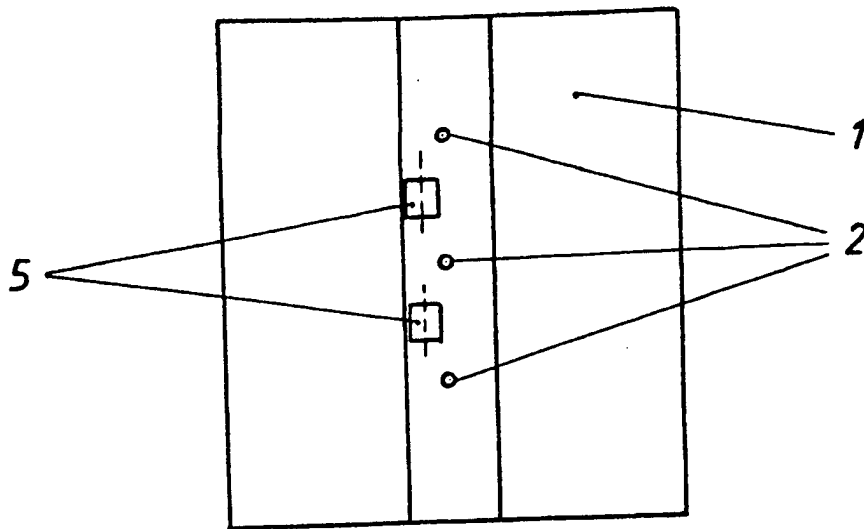


Fig. 5

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ABSTRACT OF THE DISCLOSURE:

A process is disclosed for manufacturing spunbonded webs from spun fibers or filaments or both by blow-spinning a melt or solution of a spinnable polymeric material by means of a die head with die openings, and a collector. In the area between the die heads and the collector, crimped monofilament or crimped filament yarn or a plurality thereof having a modulus of at least 1 cN/dtex are applied or introduced under tension to or into the mass of the spun fibers or filaments forming the spunbonded webs by blowing using filament or filament yarn feed nozzles. The crimped monofilament or filament yarn product added in the process has the main effect of imparting to the spunbonded webs a low and uniform density and an improved gas, vapor and liquid permeability. Elasticity is also improved.

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